Nutritional Profiling of *Ixora coccinea* Flower Extract as a Natural Food Colourant: Sensory and Nutritional Implications

DISSERTATION

Submitted in the partial fulfilment of the requirement for
The award of the degree of
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CERTIFICATE FROM THE SUPERVISOR

This is to certify that the dissertation work entitled "**Nutritional Profiling of *Ixora coccinea* Flower Extract as a Natural Food Colourant: Sensory and Nutritional Implications",** is submitted by **Ms. Debashree Karmakar (Enrolment Id: 2322229002059)** for the partial fulfilment of the degree of Master's of Science in Applied Nutrition and Dietetics under Sister Nivedita University. The entire work, which is being presented, has been carried out sincerely and satisfactorily under my supervision and guidance.

Date: 9.6.25

Place: Kolkata

Shreyasi Halder

Signature

DECLARATION BY THE STUDENT

I hereby declare that the work which is being presented in this dissertation entitled **"Nutritional Profiling of *Ixora coccinea* Flower Extract as a Natural Food Colourant: Sensory and Nutritional Implications"** in partial fulfilment of the requirements for the award of the degree of **Masters of Science** in **Applied Nutrition and Dietetics** is an authentic record of my own work carried out during the period from January 2025 to June 2025 under the supervision of **Dr. Shreyasi Halder** Department of Applied Nutrition and Dietetics ,Sister Nivedita University.

I acknowledge that I have read and understood the UGC regulations, 2018 (Promotion of Academic integrity and Prevention of Plagiarism in Higher Educational Institutions).

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Debashree Karmakar 09.06.25

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ABSTRACT

The increasing demand for natural alternatives to synthetic food colorants has prompted the exploration of plant-based pigments with added nutritional and functional benefits. This study investigates the potential of *Ixora coccinea* flower extract as a natural food colorant and evaluates its nutritional, antioxidant, and sensory properties. The flowers were collected and subjected to aqueous extraction. The extract was incorporated into food products such as lemonade, sweet curd, idli, popsicle and jelly. Sensory evaluation of the developed food products indicated acceptable color, taste, texture, appearance, and overall acceptability, suggesting consumer-friendly application of the extract. Phytochemical screening revealed the presence of flavonoids, saponins, tannins, glycosides, phenols, and anthocyanins. Quantitative analysis showed total phenolic content (52.9mgGAE/100g) in lemonade, other products don't have due to degradation during food processing and total flavonoid content (233±.03mg of RE/100g) in lemonade, (163.0±.02mg 0f RE/100g) in sweet curd, (156.3±.04mg of RE/100g) in idli and jelly doesn't contain. The antioxidant potential assessed by DPPH assay showed free radical scavenging activity IC_{50} = (111.33µg/ml) in lemonade, (162.5 µg/ml) in sweet curd , (119.93 µg/ml) in idli and (228.75 µg/ml) in jelly along with a significant vitamin C content of (61.62±.11mg/100g) in lemonade ,(58.13mg/100g) in sweet curd,(24.41±.1mg/100g) in idli whereas jelly doesn't contain. When compared with the developed food products, the bioactive compound levels were partially retained, with variations depending on the type of food matrix. This study highlights the dual potential of *Ixora coccinea* as a natural colorant and a source of nutritional antioxidants, supporting its application in functional food product development.

Keywords: *Ixora coccinea*, natural food colorant, phytochemical screening, total phenolic content, antioxidant activity, vitamin C, sensory evaluation.

INTRODUCTION

Recently food colour used a lot in food processing for increasing appetite, appearance and also its one of the important indicator of food sensory quality. Food colours are of different types, natural and artificial, also all food colours don't have nutritional values. Some studies shows that artificial food colours leads to health hazards in human. In alternate natural food colorings can be used these were easy to made, cheap and also its contributes nutritional value to food along with appealing colours [1]. Natural dyes are in trending nowadays, they have been used in different industries like textiles, cosmetics and also in food and pharmaceutical industry. Soures of natural dyes are, roots, stems, leaves, flowers, fruits, also obtained from various insects and minerals [2].

Figure 1: Different types of *ixora coccinea* (red, pink, white, yellow)

Figure 2: *Ixora coccinea* plant

Ixora coccinea Linn. Is a shrub which is known in various names like Raktaka /Rukmini/Rangan/Tetti etc. It belongs to Rubiaceae family, its leaves are obtuse, apiculate, sessile, subcordate and flowers are numerous, dense, sessile. In Ayurveda its medicinal uses were mentioned. Stems, leaves and flowers were used to treat various diseases in traditional or ancient Indian system of medicine [3]. Various bioactive compounds such as flavones, isoflavones, flavonoids, anthocyanins, coumarins, lignans, catechins, isocatechins, alkaloids, tannin, saponins, and triterpenoid are present which leads to therapeutic potential. Several colour pigments are present, anthocyanin, betalins, cyanidin, xanthophyll, cartenoids, phycoerythrin, and phycocyanin [4] Red *Ixora* is very common in everywhere, its also been used in hindu worship. The name was derived from an Indian goddess. It is native to asis and

its species from Africa to India to Southern Asia. "*Ixora*" and "*coccines*" these two words were taken from different language one from Portuguese meaning goddess Parvati and another meaning deep red coloured.[5].

Taxonomical classification of *Ixora Coccinea* [6]

Kingdom	Plantae
Division	Angiosperms
Class	Eudicots
Sub Class	Asterids
Order	Gentianales
Family	Rubiaceae
Tribe	Ixoreae
Genus	Ixora
Species	Coccinea, chinensis,parviflora, javanica, finlaysoniana

Figure 3: *Red Ixora*

Traditional uses of *Ixora Coccinea* [6]

Part	**Health Benefits**
Leaves	Wounds, Skin ulcer, hiccups, Nausea, Anorexia, Sore throat, Bronchitis cough, Asthma
Flowers	Hypertension, Irregular menstrual cycle, haemoptysis, Skin diseases, infection in female reproductive organ
Roots	Dysentery, Diarrhoea, Sores, Ulcer
Poultice of Leaves and Flowers	Sprains, Eczema, Boils, Contusion

Despite knowing the medicinal properties of the flower very limited research had been done on its application as food colourant and its implications on sensory and nutritional properties of food products. There is very few studies or no studies have been done on *I.coccinea* flower dye used as natural colour in food, taste, smell, consistency and overall acceptability. Considering rising demand of natural food colourant this research is aimed to evaluate nutritional profile of the extract and its impact on the sensory properties on food products for improving the nutritional profile and quality of food.

REVIEW OF LITERATURE

The use of natural dyes in food products were increasing day by day due to rising health concerns from artificial dye. Among many natural plant based dye, it has been seen that *Ixora Coccinea* have potential phytochemical and antioxidant activity. The literature review aims to insight the existing studies and researches been performed on *Ixora Coccinea* flower on its phytochemical and antioxidant content and its applications on various industry.

A study states that different parts of these plant is used to treat various diseases in folk medicine and ayurveda. Also, in phytochemical study they found some important phytochemical such as lupeol, urosolic acid, oleanolic acid, sitosterol, rutin, anthocyanins, proanthocyanidins, leocyanidin, glycoside of kaempferol and quercetin. Pharmacological study finds they have antioxidative, antibacterial, antidiarrhoeal, gastroprotective, hepatoprotective, antimutagenic, antineoplastic, and chemopreventive effects [7].

A study shows that it have best antioxidant property it shows lower IC50 value (6.6mg/ml for DPPH assay), and the flower extracts also shows highest phenolic content of (210.55±6.31µg/ml GAE/mg extract) [8].

Another study shows that the flower possesses significant antidiarrhoeal activity. It shows inhibitor activity against castor oil diarrhoea and induced enteropooling in rats at a dose of 400mg/kg. It inhibits intestinal motility, intestinal fluid accumulation, also reducing the frequency of defecation [9].

Some studies shows the flower have antitumor activity. The flowers increased the life span of DLA and ESC tumor bearing mice by 113 and 68% respectively. The active fraction of *I.coccinea* flower shows significant cytotoxic activity to murine tumor cells at lower concentrations [10].

In a study it shows that *I,coccinea* flower can be used as a natural indicator for acid base titration. It states that the results obtained by *I,coccinea* flower matched with standard indicator in case of weak acid and base titration [11].

It has been found that the *I,coccinea* flower was stable at high temperature,light, its anthocyanin content was sensitive in alkaline condition and stable at low ph($\leq$4). Thus this can be used as effective colour in acidic food and cosmetics [12].

The natural dye from *I,coccinea* flower was used to prepare lip balm. The was found to have good wash, rubbing and light fastness property [13]. Also in another study from using this natural dye of *I.coccinea* flower, lipstick had been prepared they also concluded that this natural coloring can be effectively used in various cosmetics preparation and a suitable alternative for synthetic colours [14].

The natural dye obtained from *Ixora Coccinea* was also used in textile industry. It was observed that methanolic extract shows better results then the aqueous extracts it yields darker shades in cotton fabric. They also concluded that the extract of *I.coccinea* flower can be used in cotton fabrication [15].

Acute toxicity studies were performed where a dose of 2000mg/kg for duration of 14 days were given to albino rats and found no motality seen and also no noticeable changes been found, it concluded as safe as it is seen that no toxicity is present. It also shows antidiabetic property by reducing the serum glucose level, body weight lipid profile and liver glycogen. This investigation also that *Ixora coccinea* flower have potential protective agents against the toxicity induced by streptozotocin [16].

While various studies have been done on its potential benefits, phytochemical content. Antioxidant activity, colour stability, application in textile and cosmetics industry, however application in food industry, how the bioactive compounds behave when added to food products have not yet performed.

AIMS AND OBJECTIVES

The research aims to evaluate the nutritional profile of ixora coccinea flower extract as a natural food colourant and also evaluate its capability to enhance the colour of food products with nutritional benefits by analysing its sensory attributes and consumer acceptance as food colourant.

The purpose of this study is -

1. To extract the bright red colors from *Ixora coccinea* flower by using simple extraction methods.
2. To prepare food products with the *Ixora coccinea* flower extract.
3. To perform a sensory evaluation of the set food products by using the colourant with a 9-point hedonic mean scale.
4. To analyse some selective phytochemical content, antioxidant activity, vitamin content of the prepared food product.
5. To compare the nutrient content of flower with the developed food products using the extract.

METHODS AND MATERIALS

- **Collection of plant material**

The flowers of *I. coccinea* was collected from the from the plants of Newtown, west Bengal. The fresh flowers were plucked in the month of February in morning. After collection the flowers were washed thoroughly and the good ones were chosen for the extraction process.

- **Colour extraction**

Aqueous extraction method was slightly modified by preparing a aqueous solution of 25 g of fresh flower and 250 ml of water as a solvent in 1:10 ratio, at a temperature of 60^0C for 20 minutes, then kept it overnight for steeping followed by it was filtered using Whatman filter paper no.1. The extract was then stored in a air tight container in refrigerator at 4^0C [17].

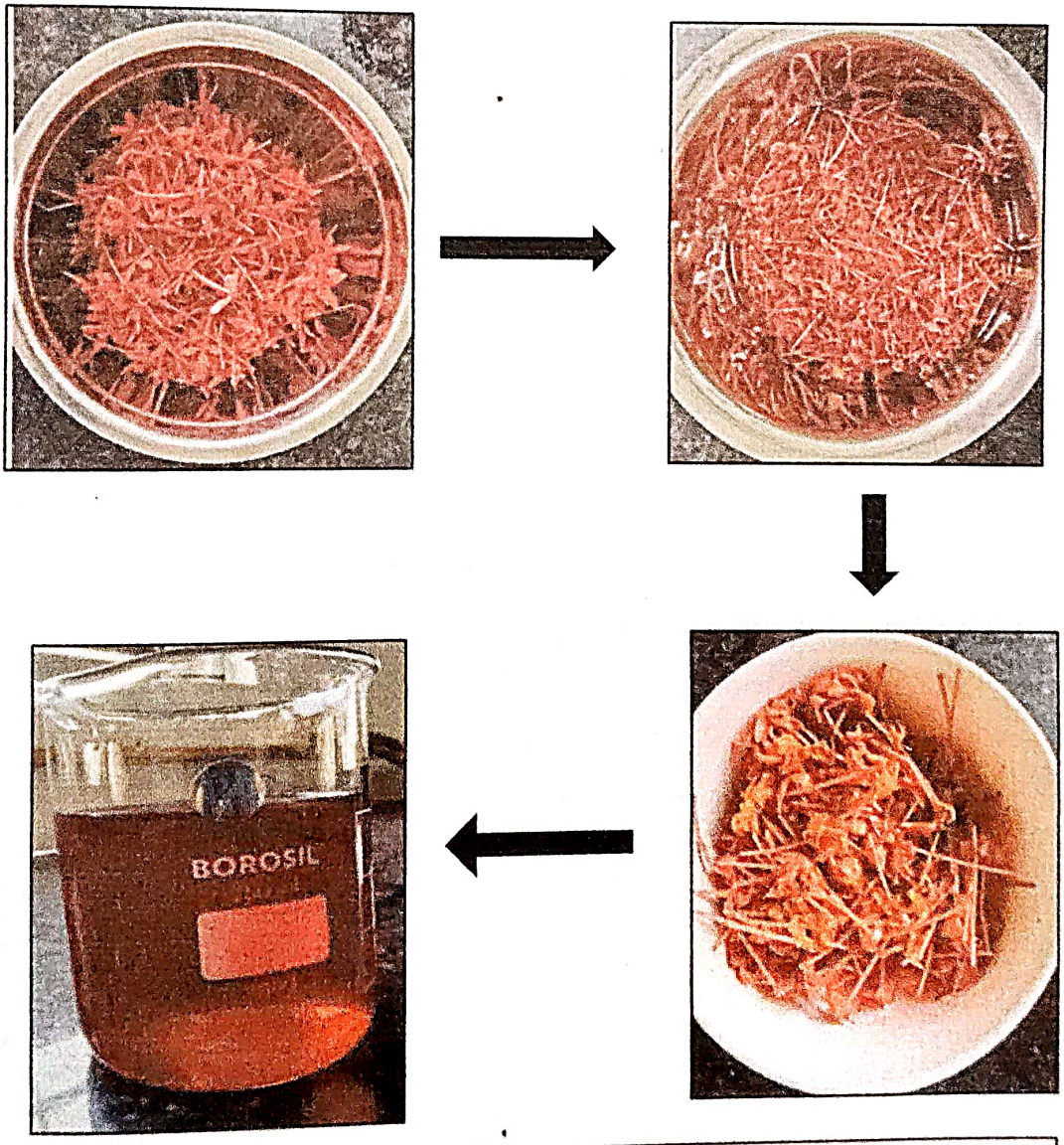

Figure 4: Schematic representation of colour extraction

- **Development of food products using fresh *Ixora coccinea* flower dye**

Food product	Ingredients	Procedure
Lemonade	Colour – 50 ml, water – 100 ml, 1 tablespoon lemon juice, slice of lemon, 3-4 mint leaves, granulated sugar – 1 tablespoon	In a glass cup 50 ml colour along with 100 ml water. Sugar and lemon juice was added and mixed thoroughly then lemon slices and mint leaves were added for flavour. Then ice cubes were added, and it was ready for sensory evaluation.
Jelly	Water – 100 ml, agar-agar powder- 1 g, granulated sugar- ½ tablespoon, colour – 10 ml	In a sauce pan 100 ml water was poured and granulated sugar was added and heated until it mixed properly, then in another pan agar was mixed with 1 tablespoon water then both the mixture was combined and boiled then simmered for 1-2 minutes then let it cool, then colour was added and mixed properly then pour in mold and refrigerate for 2-3 hours. After that the jelly was placed in plate and was ready for sensory evaluation.
Sweet curd	Milk – 50 ml, sugar – ½ tablespoon, milk powder – 1 ½ tablespoon, some cardamon, colour – 40 ml, curd – ½ tablespoon	In a pan milk was poured and sugar and cardamon was added and was boiled until sugar was completely dissolved. After boiling, milk powder was mixed. When the milk was cool at room temperature the curd was mixed evenly and poured in a cup. Then colour was added and mixed. The cup was covered using a aluminium foil, and let it incubate for 5 hours, once set it was refrigerate. The sweet curd was then served to perform sensory evaluation.
Podi Idli	Rice – 150 g, urad dal – 150 g, soda – 1 pinch, salt – as per taste, pectin – 1.2 g, colour – 15 tablespoon.	Rice and dal was washed and soaked in water overnight, then a smooth batter was prepared, soda and salt was added to batter and mixed uniformly. The microwave idli plate was greased using oil, then the batter was poured filling them ½. Then water was added for steam. The idli maker was then placed inside

		microwave and timer was set for 3 minutes. Color syrup was prepared by mixing pectin and color in a pan slightly heating, it was stirred until the pectin was mixed thoroughly and syrup consistency appeared. The idli was then taken out, garnishing been done on top then placed in plate and served for sensory evaluation.
Popsicle	Water – 250ml, colour – 50 ml, jaljeera – 1 packet, lemon- ½, sugar – 1 ½ tablesppon, salt – as per taste	Water, colour, jaljeera, lemon and salt was mixed uniformly then the mixture was poured in ice tray, then toothpick was kept. Then let it refrigerate for 2 hours. The popsicles were ready for sensory evaluation.

Figure 5: Lemonade

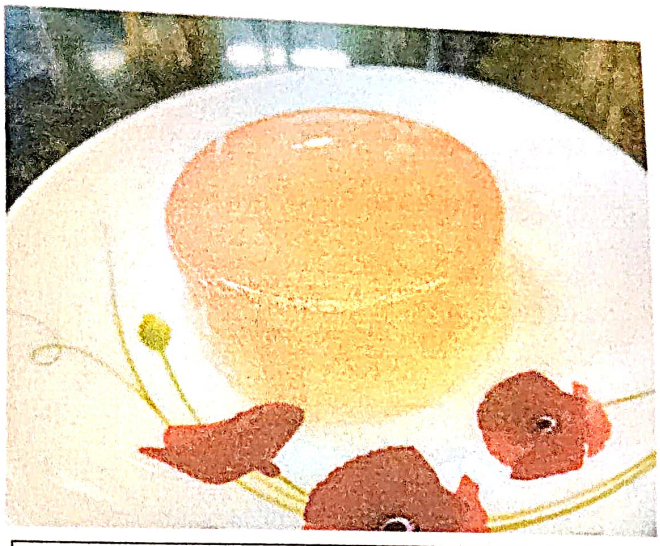

Figure 6: Jelly

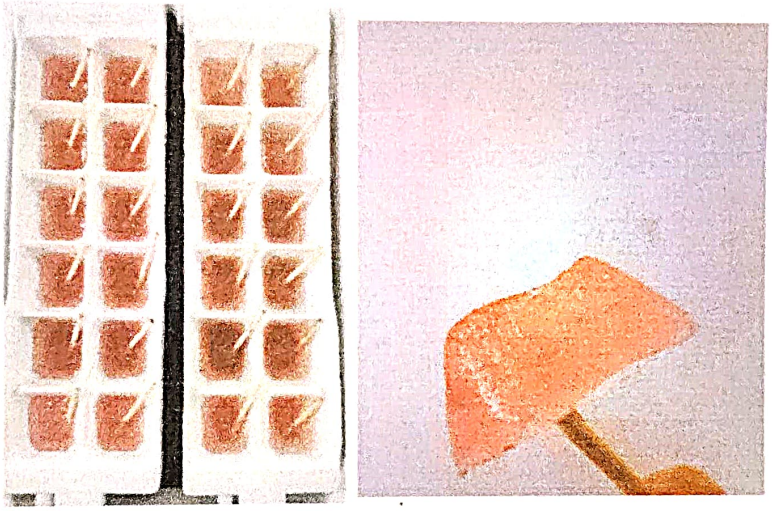

Figure 7: Popsicle

Figure 8: Sweet Curd

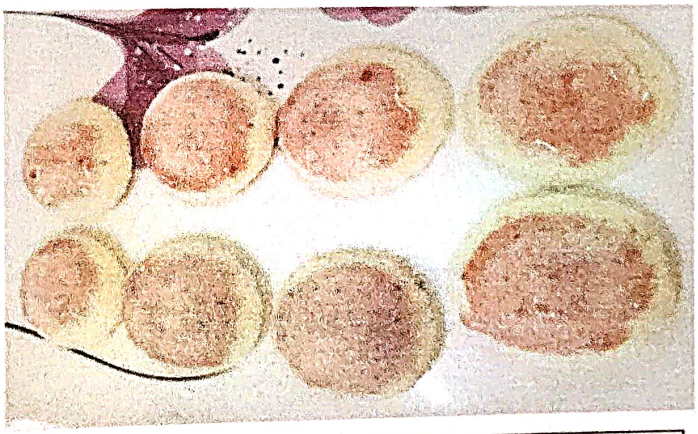

Figure 9: Podi Idli

- **Organoleptic evaluation of products by a 9 - point hedonic scale**

Considering, the need of natural food colour in india and focusing about human health, the study was designed to develop food products with of *Ixora coccinea* flower colour as natural food colorant, nutritional enhancement and to evaluate the sensory parameters of the prepared food products. Food products were prepared using basic ingredients and flower colour. Total 5 food products were prepared, and students of different streams of Sister Nivedita University (Applied Nutrition and Dietetics, Psychology, Microbiology, Biotechnology, Hotel Management) of UG and PG and teachers of the university, total 50 members (N=50) for each product have participated and compared the sensory variations of different products and rated each. The samples were evaluated by the participants according to the 9-point hedonic scale, where 1 means "dislike extremely" and 9 means "like extremely". The overall liking was considered as the mean. Participation is voluntary [18]. Each participant completed sensory sheet after tasting each product. The following characteristics were evaluated by Sensory analysis:

a) colour

b) smell

c) taste

d) consistency

e) Overall quality

The data that was obtained from the sensory evaluation was colluded in graph and presented to understand the acceptability.

SAMPLE PROFORMA FOR EVALUATION AND ACCEPTABILITY OF PRODUCTS DEVELOP USING IXORA COCCINEA FRESH FLOWER DYE

PREPARATION – IDLI

Sl.No:

Name:

Date:

HEDONIC SCALE	COLOUR	SMELL	TASTE	CONSISTENCY	OVERALL QUALITY
9. Like extremely					
8. Like very much					
7. Like moderately					
6. Like slightly					
5. Neither like nor dislike					
4. Dislike slightly					
3. Dislike moderately					
2. Dislike very much					
1.Dislike extremely					

Signature

SAMPLE PROFORMA FOR EVALUATION AND ACCEPTABILITY OF PRODUCTS DEVELOP USING IXORA COCCINEA FRESH FLOWER DYE

PREPARATION – SWEET CURD

Sl.No:

Name:

Date:

HEDONIC SCALE	COLOUR	SMELL	TASTE	CONSISTENCY	OVERALL QUALITY
9. Like extremely					
8. Like very much					
7. Like moderately					
6. Like slightly					
5. Neither like nor dislike					
4. Dislike slightly					
3. Dislike moderately					
2. Dislike very much					
1.Dislike extremely					

Signature

SAMPLE PROFORMA FOR EVALUATION AND ACCEPTABILITY OF PRODUCTS DEVELOP USING IXORA COCCINEA FRESH FLOWER DYE

PREPARATION – JELLY

Sl.No:

Name:

Date:

HEDONIC SCALE	COLOUR	SMELL	TASTE	CONSISTENCY	OVERALL QUALITY
9. Like extremely					
8. Like very much					
7. Like moderately					
6. Like slightly					
5. Neither like nor dislike					
4. Dislike slightly					
3. Dislike moderately					
2. Dislike very much					
1.Dislike extremely					

Signature

SAMPLE PROFORMA FOR EVALUATION AND ACCEPTABILITY OF PRODUCTS DEVELOP USING IXORA COCCINEA DRIED FLOWER DYE

PREPARATION – POPSICLE / ICE POPS

Sl.No:

Name:

Date:

HEDONIC SCALE	COLOUR	SMELL	TASTE	CONSISTENCY	OVERALL QUALITY
9. Like extremely					
8. Like very much					
7. Like moderately					
6. Like slightly					
5. Neither like nor dislike					
4. Dislike slightly					
3. Dislike moderately					
2. Dislike very much					
1.Dislike extremely					

Signature

SAMPLE PROFORMA FOR EVALUATION AND ACCEPTABILITY OF PRODUCTS DEVELOP USING IXORA COCCINEA DRIED FLOWER DYE

PREPARATION – LEMONADE

Sl.No:

Name:

Date:

HEDONIC SCALE	COLOUR	SMELL	TASTE	CONSISTENCY	OVERALL QUALITY
9. Like extremely					
8. Like very much					
7. Like moderately					
6. Like slightly					
5. Neither like nor dislike					
4. Dislike slightly					
3. Dislike moderately					
2. Dislike very much					
1.Dislike extremely					

Signature

Preliminary phytochemical screening [19]

Phytochemical screening was done to detect the bioactive compounds that are present in food products prepared using *ixora coccinea* flower dye and to study whether the food products retain the compounds that present in the flower.

Preparation of working solution of samples

1g of food products (jelly, sweet curd, podi idli, lemonade) were taken and were grind using mortar and pestle and extracted using methanol by maceration method overnight, then the samples were filtered and stored for phytochemical screening.

- **Test for saponins (FoamTest):**

1 ml extract was taken in test tube and diluted with 2 ml distilled water. Agiated the mixture for 15 minutes, the persistent foam form confirm the presence of saponins.

- **Test for flavonoids (Alkaline Reagent Test):**

To 1ml of extract 2-3 drops of sodium hydroxide (NaOH) were added, formation of yellow colour confirm the presence of flavonoids.

- **Test for phenols (ferric chloride test):**

To 1ml of extract, 1ml distilled water was added then 10% ferric chloride was added to observe a blue, black, green colouration depending upon phenol compounds present.

- **Test for glycosides:**

To 2ml of extract, 3ml chloroform and 10% ammonia solution was added in a test tube, formation of pink colour confirms the presence of glycoside.

- **Test for tannins (Braymer's test) [20]:**

To 1ml of extract 2ml of 10% alcoholic ferric chloride was added, and a greenish, blue or brown colour observe confirms presence of tannins.

- **Test for Anthocyanins [18]:**

To 2ml of extract, 2ml of 2(N) HCL was added and 2-3 drops of ammonia solution was added in test tube. The appearance of pink red colour which changes to purple blue confirms the presence of anthocyanins.

Antioxidant Assay [21]

- **Determination of flavonoids**

Total flavonoid content of the flower samples were determined using aluminium chloride colorimetric assay.

To 1ml standard and stock solution, 4ml distilled water was taken then 0.3ml of 5%$NaNO_3$ (because in lab we don't have $NaNO_2$) was added after 5 minutes 0.3ml of 10%$AlCl_3$ was added. Wait for 6 minutes, then 2ml of 1M NaOH and 2.4 ml distilled water was added to the mixture, solution was vortexed for few seconds then kept at room temperature for 15minutes. The absorbance was taken at 410nm by UV- visible double beam spectrophotometer. Samples of extract has been assessed at concentrations of (100-500) µg/ml. Total flavonoid content was expressed in Rutin equivalent, mg RE/100g of dry extract.

- **Determination of phenols**

Total phenolic contents in the extracts were determined by the modified Folin- Ciocalteu method.

0.5ml of aliquots of concentration (10-50) µg/ml were taken and mixed with 2.5 ml of Folin Ciocalteu reagent (diluted with distilled water 1:10v/v), after 3 mins 2.5ml (75g/l) sodium carbonate was added. The sample was vortexed for 10 seconds allowed to stand for 30 minutes at 25°C for blue colour development. Absorbance was then measured at 765nm using UV-visible double beam spectrophotometer. Samples of extract was assessed at concentrations of (10-50) µg/ml. Total phenol content was expressed as mg of GAE /100g dry extract.

- **DPPH Free Radical Scavenging Activity**

The free radical scavenging activity of food products made from *Ixora coccinea* flower dye was determined by DPPH assay. Discoloration was measured at 517 nm after incubation for 30 min. Measurements were made in triplicate.

Preparation of reagent:

0.1mM DPPH solution was prepared by dissolving 0.4mg of DPPH into 10 ml of methanol, and stored in a dark place in a air tight container.

Standard solution preparation:

Ascorbic acid was used as standard. 10mg of ascorbic acid was taken and dissolved in 10ml of methanol to made concentration (1mg/ml)

Procedure:

1ml of food sample was taken then 2ml od DPPH solution was added to each sample, dilution was (100-500µg/ml) for standard and test samples, and incubated for 30minutes in a dark place. Total 3ml volume was made in each test tube, after incubation the absorbance was recorded by using UV- visible double beam spectrophotometer.

The IC50 value was calculated from the graph plotted from % inhibition and concentration of test samples. The results were presented as IC50 values and ascorbic acid equivalent of food products developed.

Percentage scavenging of the DPPH free radical was measured using the following equation [18].

$$\% \text{ radical scavenging assay} = \frac{\text{absorbance of control} - \text{absorbance of sample}}{\text{Absorbance of control}} \times 100$$

Here, Absorbance of control = absorbance of DPPH radical + aqueous methanol;

Absorbance of sample =absorbance of DPPH radical + standard / food product

The blank was prepared by using 80% methanol.

- **Estimation of ascorbic acid [22]**

Standard: 5ml of ascorbic acid was taken in 100ml conical flack and 3%metaphosphoric acid was added to it and titrated against the DCPIP (2,6-dichlorophenol indophenol) dye. The pink color that persists for 10 seconds, indicates the end point. The amount of ascorbic acid was equal to amount of dye consumed.

Sample: 5 ml of food sample, which was blended prior with mortar and pestle, and extracted by diluting in metaphosphoric acid. The pink appeared and persists indicates the end point. Reading was taken thrice.

Calculation:

Ascorbic acid = [volume of dye required for titrate sample/volume of dye required for titrate standard] ×concentration of standard×100

RESULTS AND DISCUSSION

In ancient the flowers were used in wide range mostly in preparing teas, wines, for medicinal purpose, culinary, decoration and also used in jams, sauces, marinades etc. In several Asian regions, such as Thailand, the flowers to add visual and sensory appeal to dishes. They are often added to summer salads, used in desserts like sorbets and ice creams. In Thai cuisine, *Ixora* flowers are coated in batter and deep fried to make crunchy tempura [23]. Acute toxicity studies been conducted on albino rats revealed no mortality rate even at high dose of 2000mg/kg over a 14 days observation period. No abnormal behaviour or changes been noted, suggesting the safety and non-toxic nature of the extract [16]. In cosmetic industry the petals of *I.coccinea* was used to formulate lipstick, which was derived from natural pigment present in the flower [24].

However, despite its rich nutritional and therapeutic profile there is no such application of colour in food industry. Thus, in order to develop a natural colour which is also nutrient rich and can safe for human consumption these products were been developed and results were summarized below;

- **Formulation and sensory evaluation of food products developed from fresh *Ixora coccinea* flower dye**

The sensory attributes are (colour, smell, taste, consistency, overall quality), the scores were based on hedonic scale where 1 represented "dislike extremely" and 9 represented "like extremely".

Table 1: Mean hedonic value of food products evaluated by participants

Product	Colour	Smell	Taste	Consistency	Overall quality
Lemonade	8.64	7.94	8.2	8.1	8.5
Jelly	7.94	6.98	7.86	7.96	8.16
Sweet curd	8	8.04	8.54	7.94	8.38
Podi idli	7.96	7.14	7.7	7.78	7.68
Popsicle	7.94	6.98	7.88	7.44	7.94

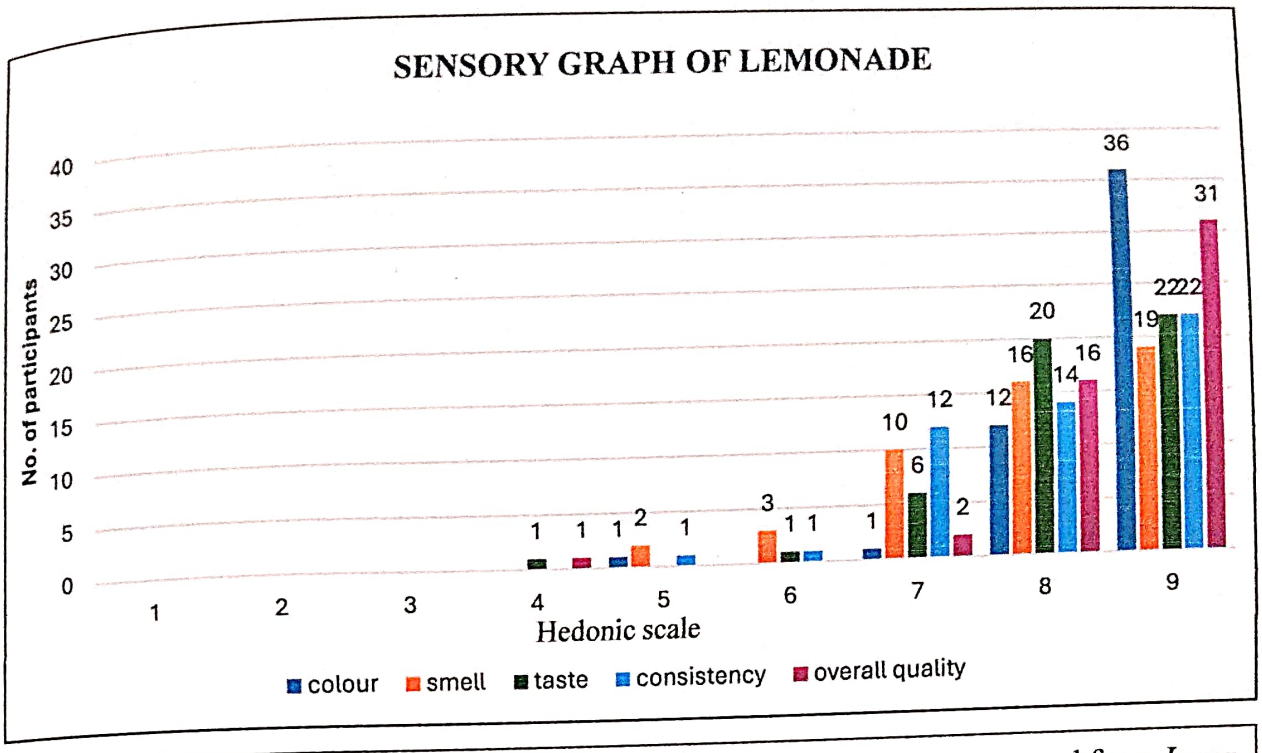

Figure 10: Graphical representation of organoleptic study of lemonade prepared from *Ixora coccinea* flower dye

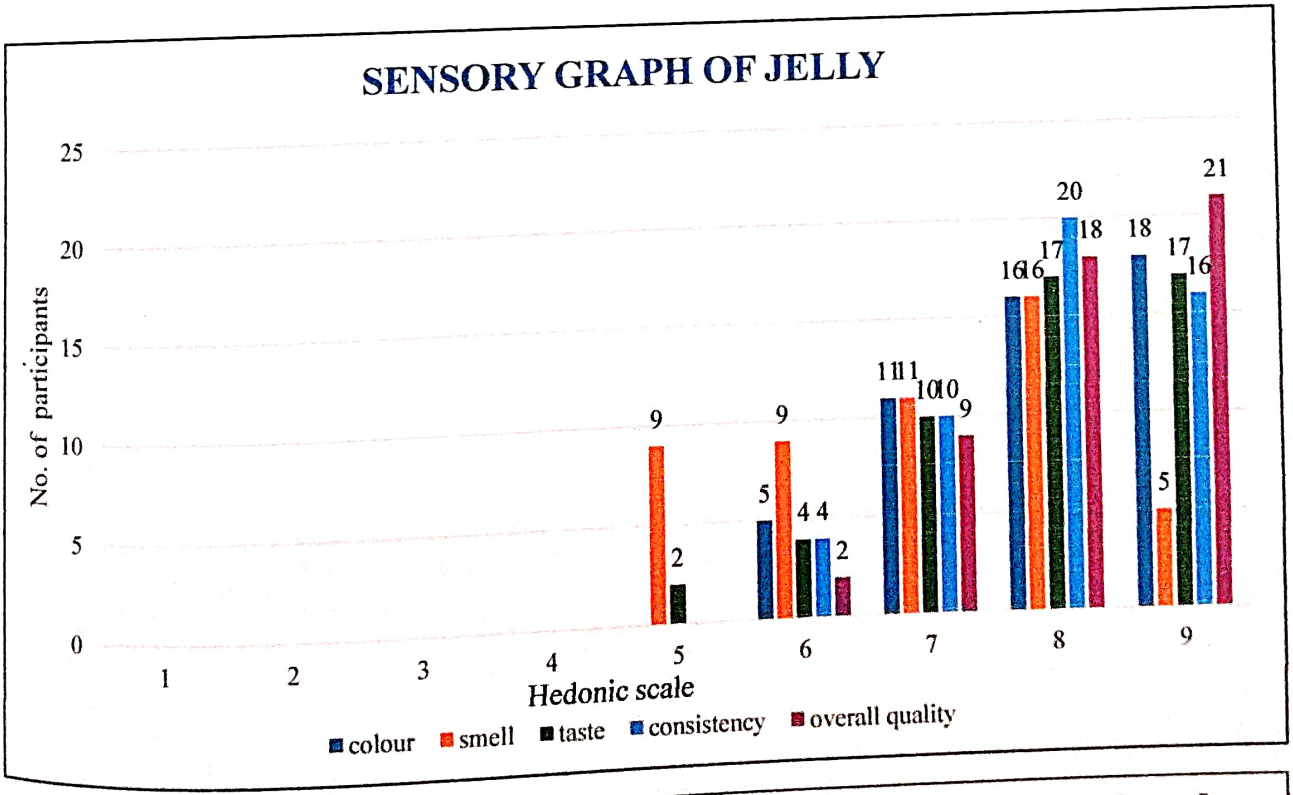

Figure 11; Graphical representation of organoleptic study of jelly prepared from *Ixora coccinea* flower dye

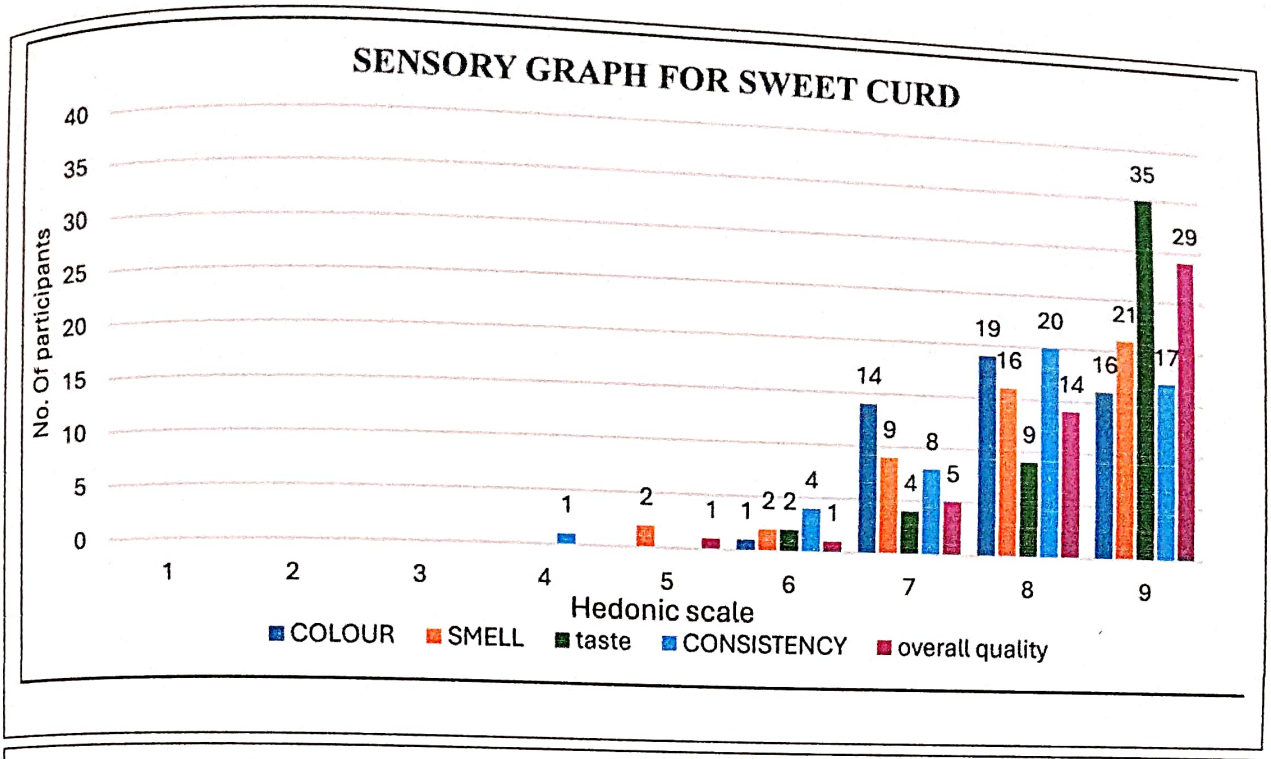

Figure 12; Graphical representation of organoleptic study of sweet curd prepared from *Ixora coccinea* flower dye

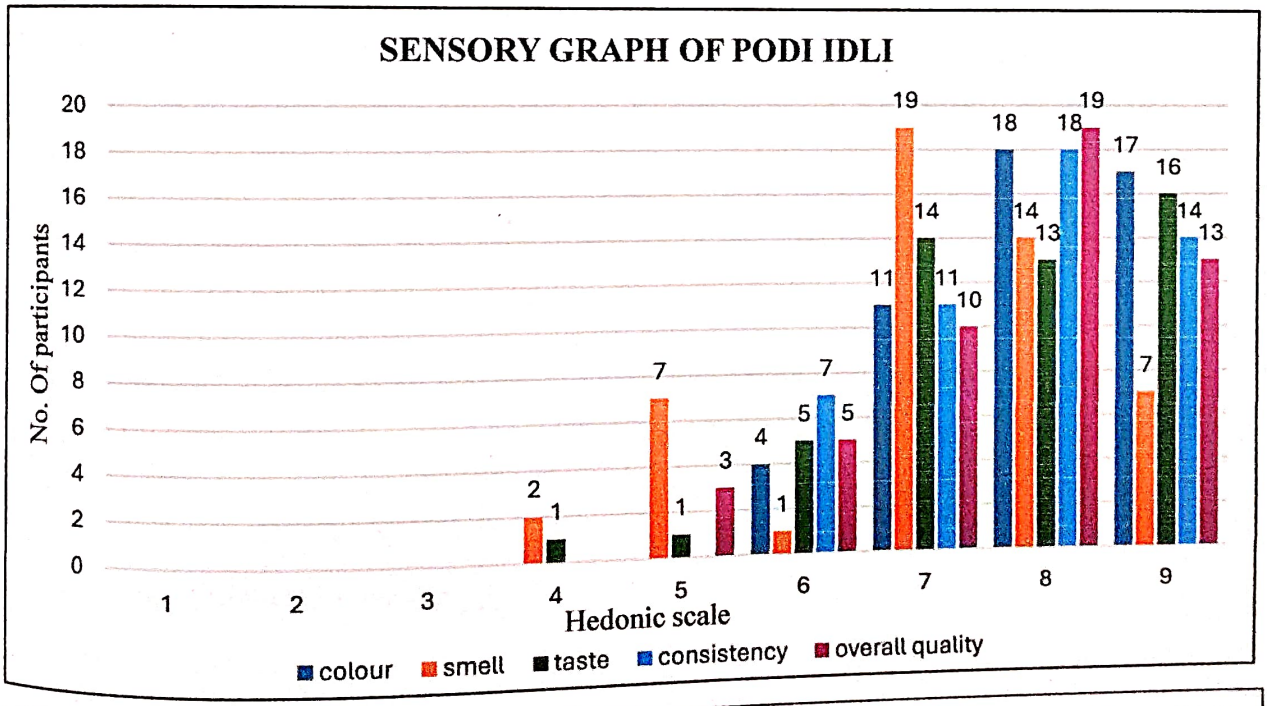

Figure 13; Graphical representation of organoleptic study of podi idli prepared from *Ixora coccinea* flower dye

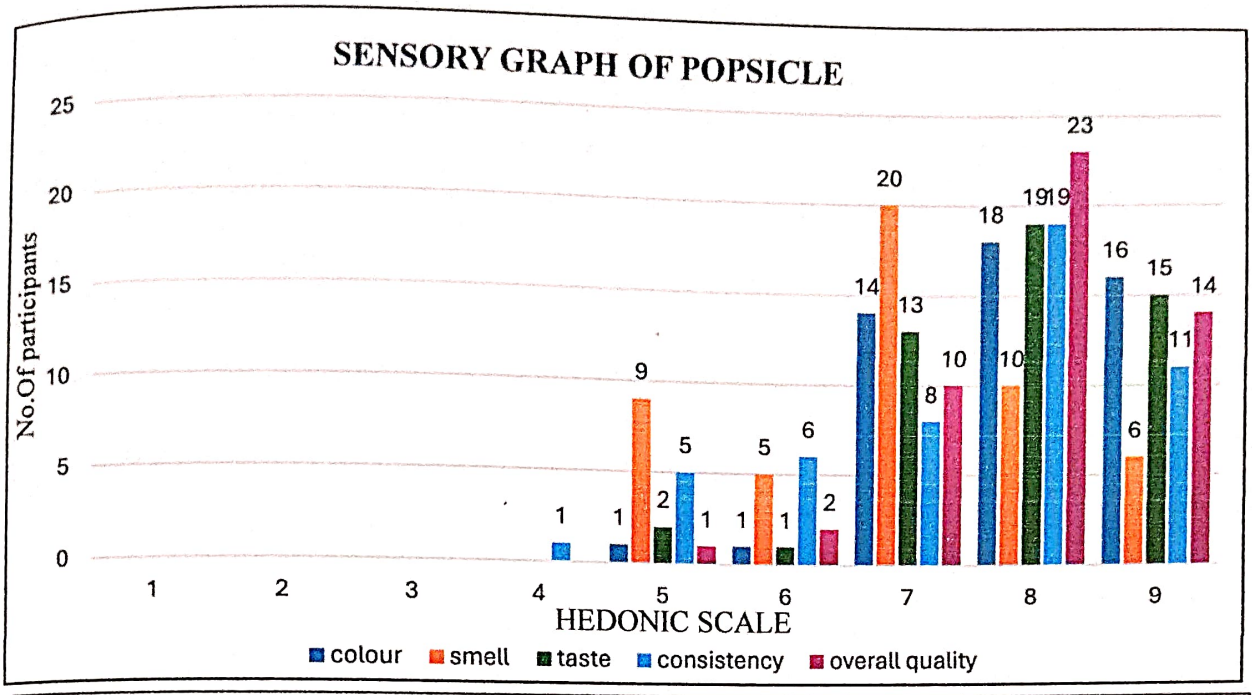

Figure14; Graphical representation of organoleptic study of popsicle prepared from *Ixora coccinea* flower dye

From the above table 1 and figure 10, 11, 12, 13 and 14 we have derived some conclusions;

Colour: Among the five products, lemonade received the highest response (8.64) due its unique bright red colour which participants found appealing, whereas, sweet curd (8), podi idli (7.96) and popsicle and jelly have (7.94).

Smell: Highest response received by sweet curd (8.04), and lowest response was tied up by popsicle and jelly (6.98), lemonade (7.94) and podi idli (7.14) were in between.

Taste: Highest was received by sweet curd (8.54), lowest was got by podi idli(7.7), and jelly (7.86), lemonade (8.2), and popsicle (7.88), were in between.

Consistency: highest was received by lemonade (8.1), lowest was popsicle (7.44), because it melts quickly, following jelly (7.96), sweet curd (7.94) and podi idli (7.78).

Overall quality: highest was received by lemonade (8.5), lowest was podi idli(7.68).

From the above conclusion we got that lemonade received the highest response for all the sensory attributes comparing to other products by the participants.

▪ Preliminary phytochemical screening

Table 2: preliminary qualitative phytochemical screening of food products developed using *Ixora coccinea* flower dye

Test for phytochemicals	Methods	Methanol extract			
		Jelly	Curd	Lemonade	Idli
Test for saponins	Foam test	++	++	++	++
Test for flavonoids	Alkaline reagent test	+	+	+++	+
Test for phenols	Ferric chloride test	-	-	++	-
Test for Anthocyanins	Phillipson's test	+	+	++	+
Test for tannins	Braymer's test	+	+	+	+
Test for glycoside	Borntrager's test	-	-	-	-

+++: highly present, ++; moderately present, +: present, -: absent

From the above table 2, we can observe that; the methanol extract of the above food samples have saponins, flavonoids, phenols, anthocyanins, tannins whereas glycoside is absent in all the food products.

Also it was observed that, lemonade have the maximum phytochemical presence in compare to other 3 products.

Figure 15: (from left to right) foam formation (presence of saponin), yellow colour (presence of flavonoid), greenish (presence of phenol)

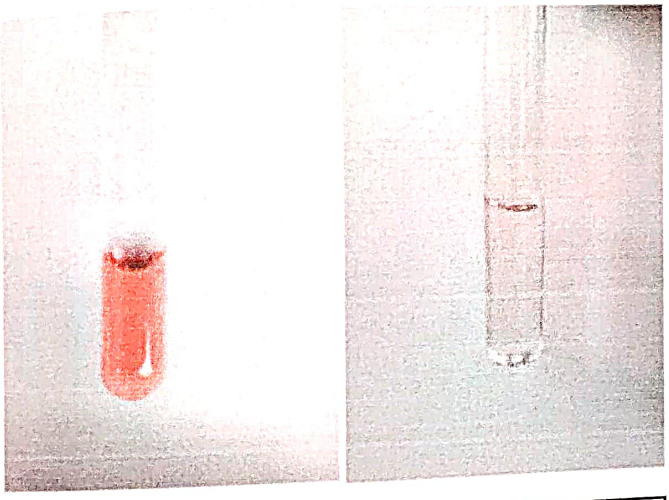

Figure 16: (left) anthocyanin dark (++), (right)anthocyanin light (+)

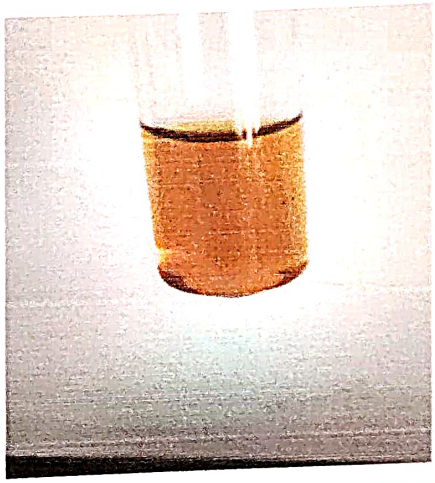

Figure 17: brown color (presence of pseudo) tannins

Determination of total flavonoids

Flavonoids are significant groups of natural compounds, classified as plant secondary metabolites characterized by their polyphenolic structure. Flavonoids prevent and manage several diseases like cancer, Alzheimer's disease (AD), atherosclerosis. Its subtypes are flavones, flavonols, and isoflavones [25]. In this study the total flavonoid content (TFC) of food product formulated using *I.coccinea dye* was performed by aluminium chloride colorimetric assay. The total flavonoid content values were obtained from the calibration curve. The calibration curve and the linear equation obtained was $y= 0.0009x+0.0463$, $R^2=0.9962$, where

x is the absorbance and y is concentration of rutin solution(µg/ml), expressed as mg of rutin equivalent per 100 gram of extract. Figure 21 shows rutin standard curve.

Table 3: TFC estimation of food products

Concentration (µg/ml)	Lemonade (mg of RE/100g)	Sweet curd (mg of RE /100g)	Podi Idli (mg of RE/100g)
200	6.33±0.03	28.6±0	30±0.07
400	66.3±0	57.4±0.56	38.6±0.06
600	125.2±0.09	102.±0.08	53±0.02
800	181.9±0.02	125.2±0.07	106.3±0.04
1000	233±0.03	163.0±0.02	156.3±0.04

Data expressed as mean ± sd

From the above table 3: it is concluded that lemonade, sweet curd, podi idli have flavonoid incorporation, but jelly shows negative results which signifies that negligible or no flavonoid present due to possible factors such as, interaction with other ingredients. Poor absorption, degradation etc.

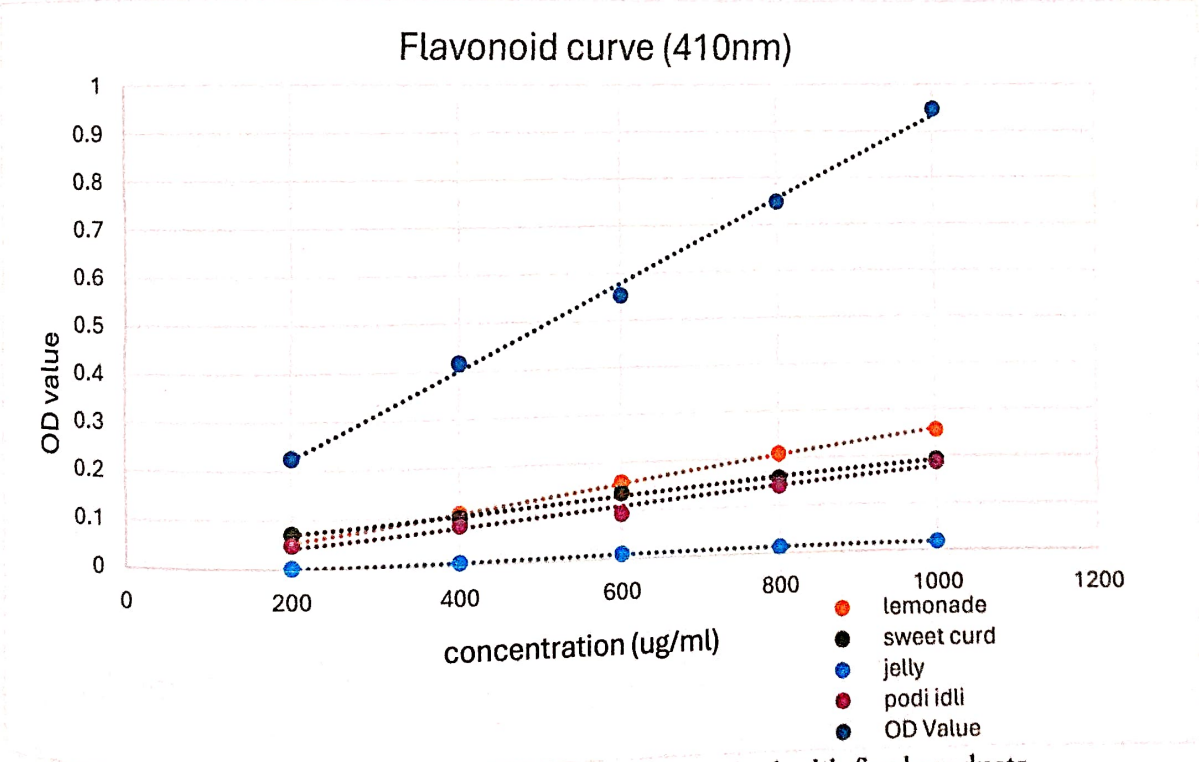

Figure 18: Graphical representation of standard with food products

Determination of total phenols

Phenols have antioxidant properties, because they can donate one hydrogen from phenolic hydroxyl groups. The consumption have many beneficial effects, they can protect human from free radicals which leads to cardiovascular, cancer, inflammatory, and neurodegenerative diseases [26]. Total phenolic content (TPC) of lemonade was studied by performing by Folin – Ciocalteu (F-C) assay. The calibration curve and the linear equation obtained was y= 0.0086x+0.2051, R^2 = 0.9925, where x is the absorbance and y is concentration of galic acid solution(µg/ml), expressed as mg of GAE/100 g of extract. Figure 22 shows galic acid standard curve.

Table 4: TPC estimation of food products

Concentration (µg/ml)	Lemonade (mg of GAE/100g)
10	1.73
20	13.70
30	25.00
40	42.50
50	52.9

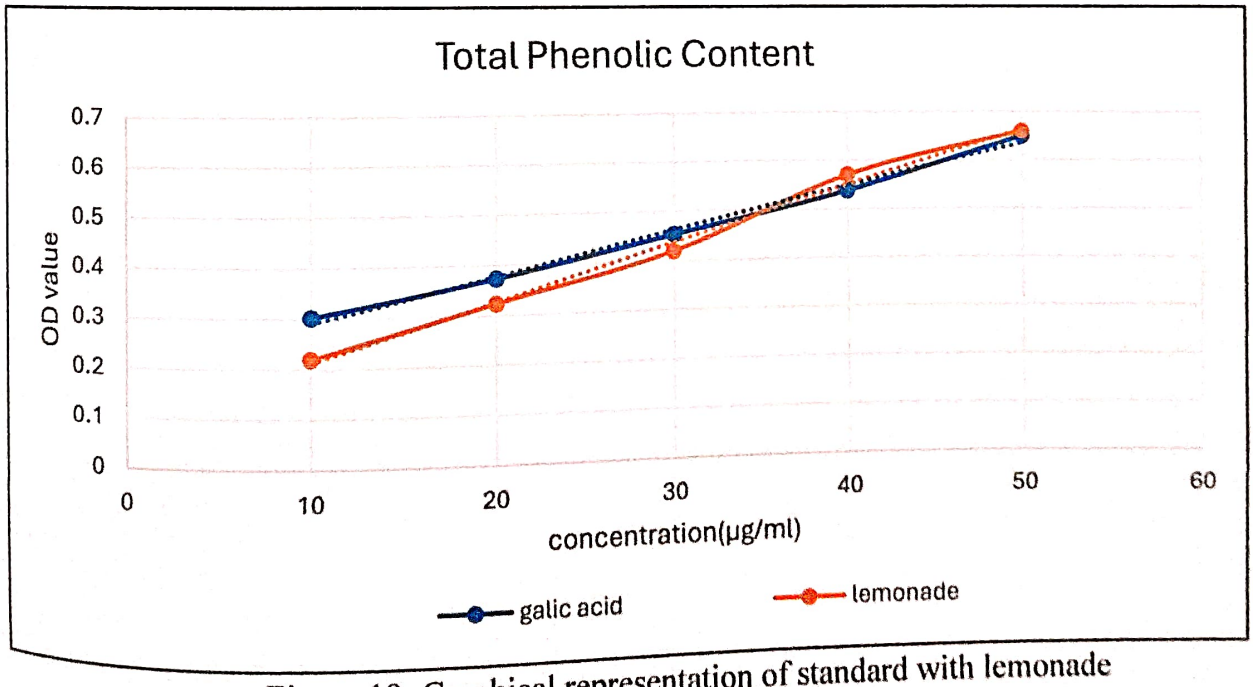

Figure 19: Graphical representation of standard with lemonade

DPPH free radical scavenging activity:

The 2, 2-Diphenyl-1- picrylhydrazyl (DPPH) is one of the most commonly employed method for evaluating the antioxidant activity of the plant extracts. it measures the ability of compounds to act as free radical scavengers. In this method the antioxidant activity of the food products formulated using *I.coccinea* flower dye was assessed using DPPH, a stable nitrogen centered free radical. Under reduction DPPH undergoes a color reduction from violet to yellow. Figure 23; shows ascorbic acid % inhinition.

Table 5: % inhibition and IC50 values of food products and ascorbic acid at different concentrations for DPPH Assay.

concentration(µg/ml)	Ascorbic acid	Lemonade	Sweet Curd	Podi Idli	Jelly
100	56.69	48.57	45	47.85	36.66
200	60.23	61.9	53.57	59.82	49.28
300	66.14	79.28	57.14	71.9	55.95
400	72.44	88.66	62.85	80	66.19
500	80.11	88.57	70.47	84.76	77.61
IC50(µg/ml)	11.23	111.33	162.5	119.93	228.75

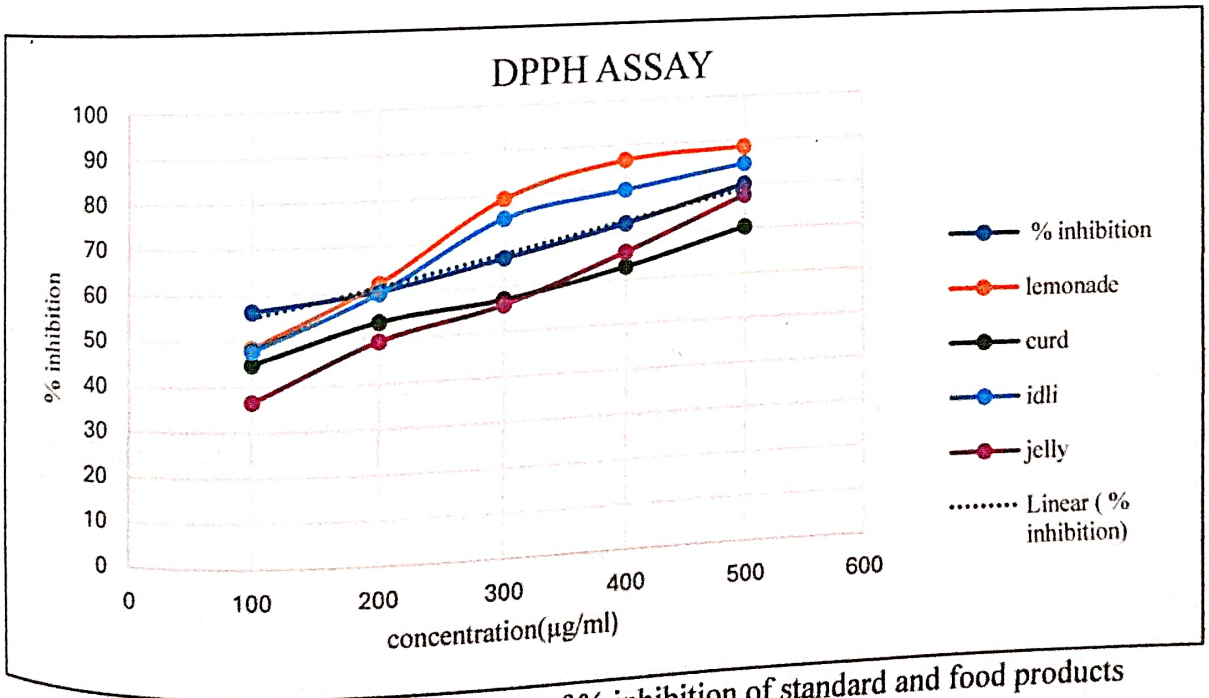

Figure 20: Graphical representation of % inhibition of standard and food products

STANDARD CURVE (FOR FLAVONOID, PHENOL, DPPH)

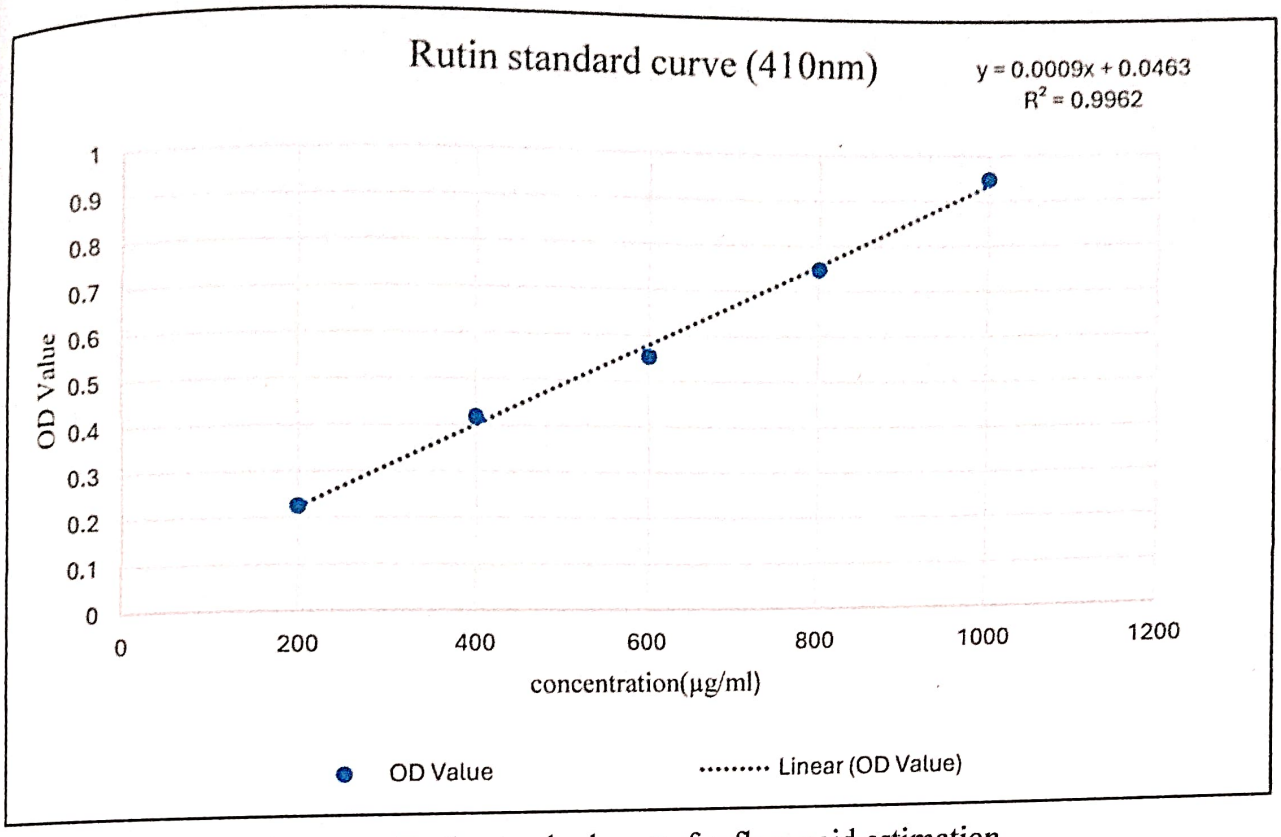

Figure 21: Rutin standard curve for flavonoid estimation

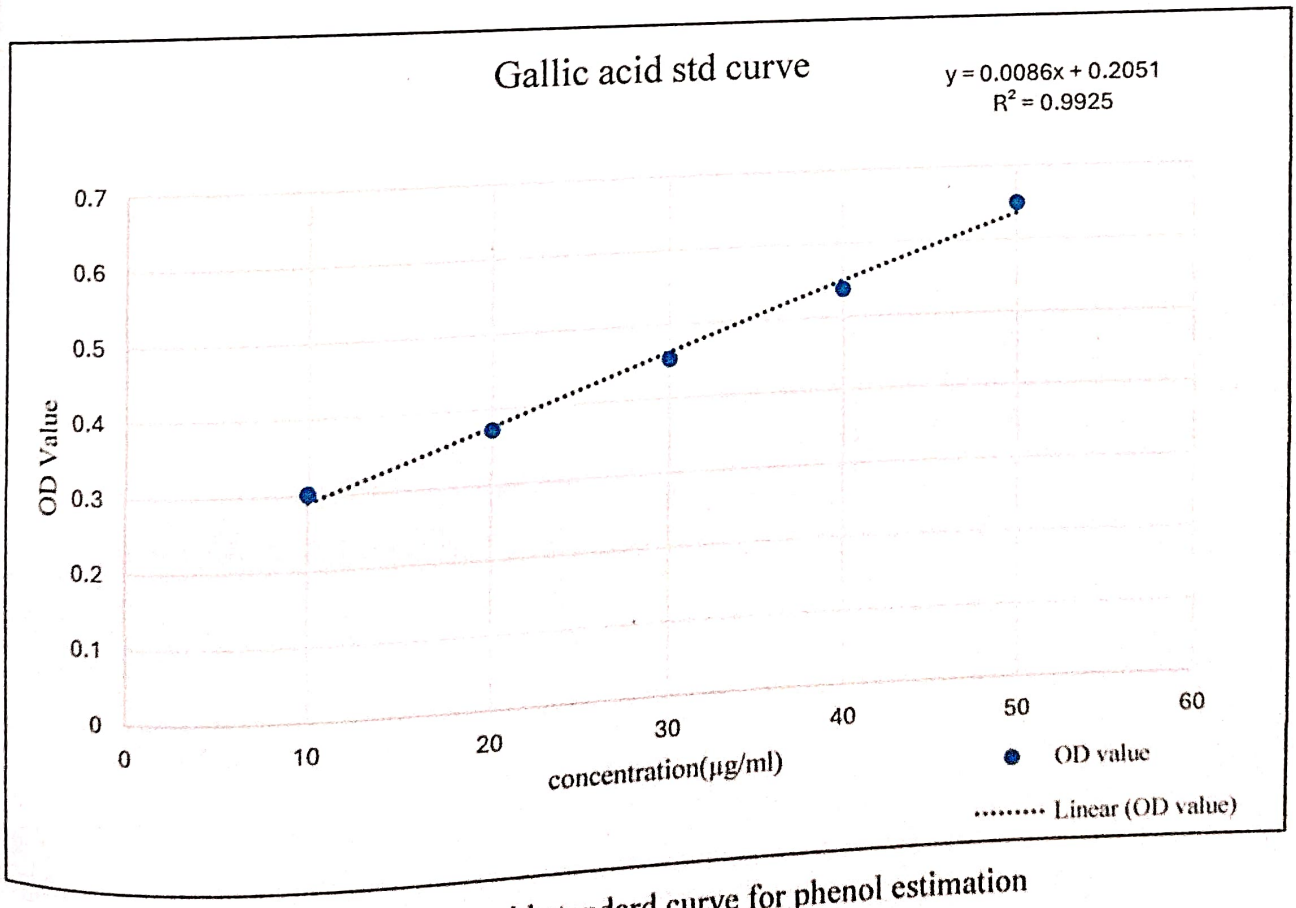

Figure 22: Galic acid standard curve for phenol estimation

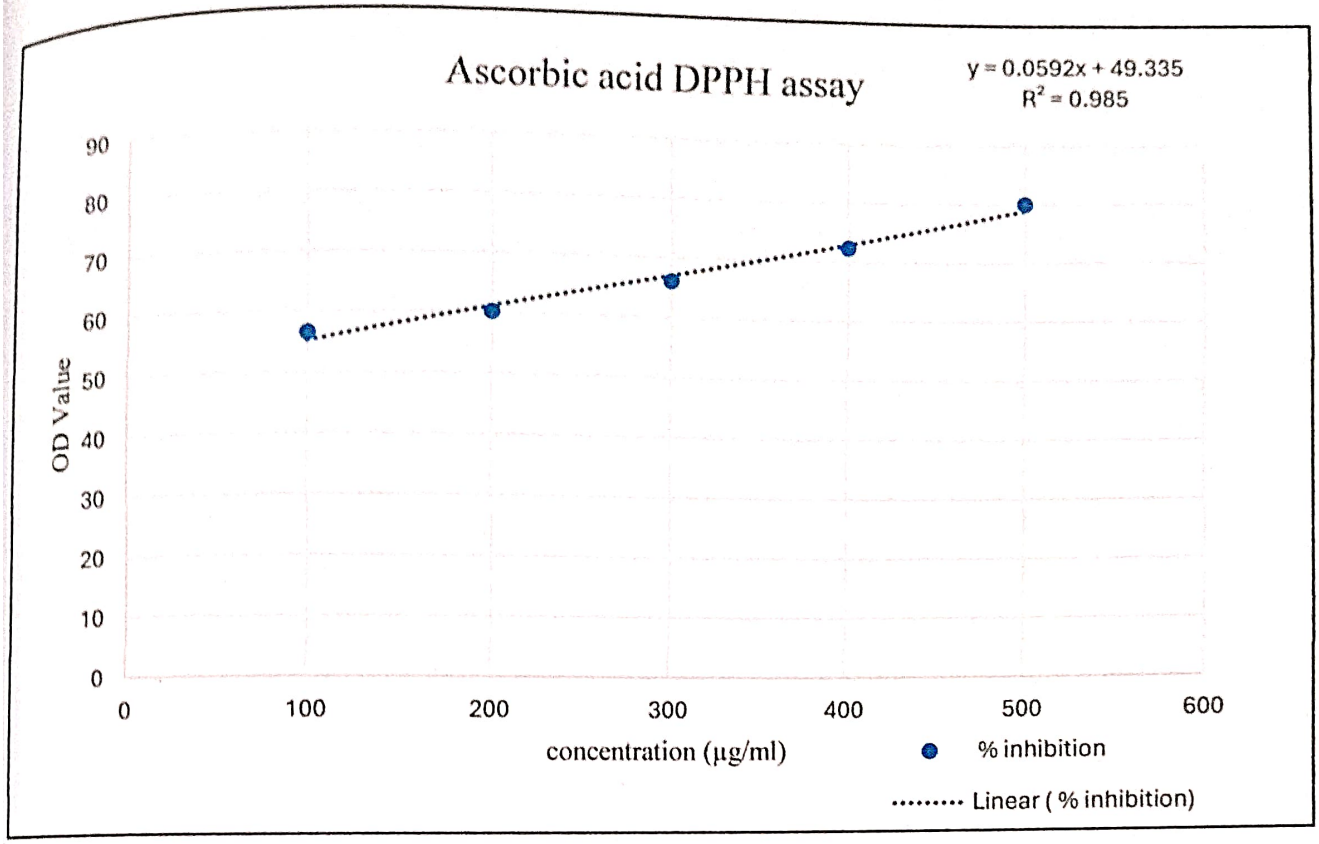

Figure 23: Percentage inhibition curve of ascorbic acid as standard for DPPH assay

Estimation of ascorbic acid

Vitamin C performs a variety of essential functions in the human body. Its biochemical roles include the activation of specific enzymes, synthesis of collagen, regulation of hormones, antioxidant activity. It has been linked to reduced risk of cancer, improved blood pressure regulation, enhanced immune response. Here amount of ascorbic content present in the food products was estimated by titration method using DCPIP (2,6-dichlorophenol indophenol).

Table 6: Ascorbic acid content of food products

Food product	Ascorbic acid (mg/100g)
lemonade	61.62±0.11
Sweet curd	58.13
Idli	24.41±0.1

Data expressed as mean ± sd(standard deviation)

From table 6; lemonade contained highest **61.62mg/100g**, then sweet curd **58.13 mg/100g**, and then lowest in idli **24.41mg/100g** of ascorbic acid. Jelly doesn't show any colour change, it means no vitamin C is present in it. This variation may be due to differences in preparation methods, exposure to heat, oxygen, and light during processing, or storage conditions. As vitamin C is a heat-sensitive and water-soluble compound, degradation is common in thermally processed or stored products.

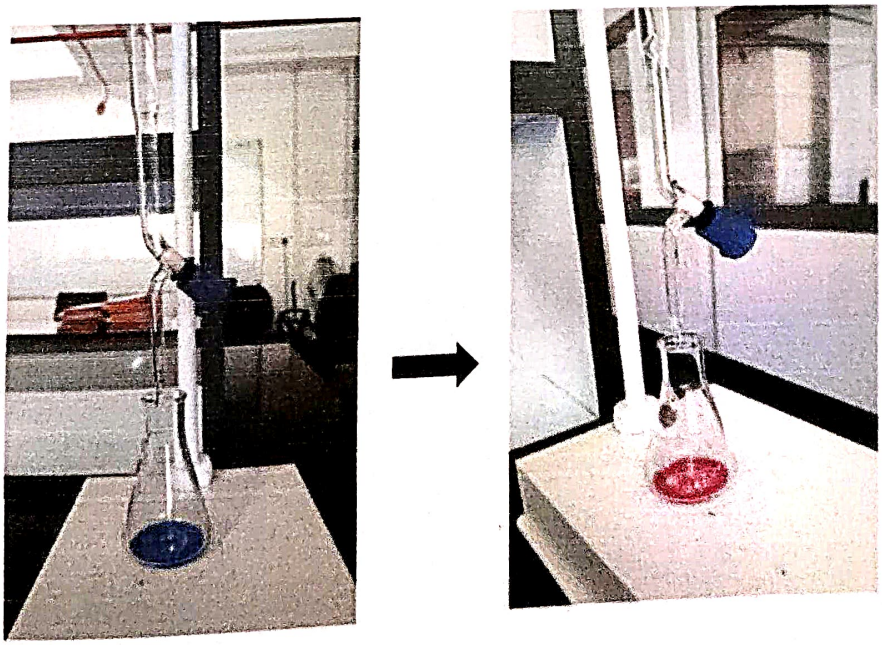

Figure 24: Vitamin C estimation (colour changes from blue to pink)

Comparison of nutrient content of food products with that of flower

Table 7: Comparison of phytochemical content of flower and developed food products

Phytochemicals	Flower	lemonade	Sweet curd	Idli	Jelly
Saponins	+	+	+	+	+
Flavonoid	+	+	+	+	+
Phenol	+	+	-	-	-
Tannins	+	+	+	+	+
Glycoside	+	-	-	-	-
Anthocyanin	+	+	+	+	+

+ = present, - = absent

Table 8: Comparison of antioxidant content (TPC, TFC, DPPH) and Vitamin C content of flower and developed food product

Parameters	Flower	lemonade	Sweet curd	Idli	Jelly
Total flavonoid content	214.9 µg QAE/mg	233±0.03 mg RE/mg	163.0±0.02 mg RE/mg	156.3±0.04 mg RE/mg	-
Total phenolic content	210.55±6.31µg/ml GAE/mg extract	52.9±.0 mg of GAE/100g	-	-	-
DPPH % scavenging activity	6.6mg/ml	0.1113mg/ml	0.1625 mg/ml	0.1199mg/ml	0.2287mg/ml
Vitamin c	58.92 µg/ml	616.2±0.11 µg/ml	581.3 µg/ml	244.1±0.1 µg/ml	-

Table [7] presents a comparative evaluation of phytochemical constituents between *Ixora coccinea* flower extract and its incorporation into various food products, including lemonade, sweet curd, idli, and jelly. Phytochemical screening revealed the consistent presence of saponins, flavonoids, tannins, and anthocyanins across all samples. However, phenols and glycosides were detected only in the flower extract and lemonade, while absent in sweet curd, idli, and jelly, suggesting a partial loss of these compounds during food processing.

Table [8] presents that, Total flavonoid content (TFC) was highest in lemonade (233 µg RE/mg) compared to the flower extract (214.9 µg QAE/mg), possibly due to additive interactions or concentration effects. Sweet curd and idli showed moderate TFC values (163.0 and 156.3 µg RE/mg respectively), while TFC was not determined in jelly. Total phenolic content (TPC) was significantly higher in the flower extract (210.55±6.31 µg GAE/mg), while lemonade retained some phenolic content (52.9 µg GAE/mg). TPC was undetectable in the other products, indicating that phenolic compounds may degrade or become bound during processing. DPPH radical scavenging activity, expressed as IC_{50} values, was lowest (i.e., best antioxidant activity) in the flower extract (6.6 mg/mL) and highest in jelly (0.2287mg/mL), indicating that antioxidant capacity diminishes in processed foods. Vitamin C content was fairly retained in lemonade (616.2 µg/mL) and sweet curd (581.3 µg/mL), with idli showing a marked reduction (244.1 µg/mL). This suggests that the acidic or fermented matrices like lemonade and curd may better preserve vitamin C compared to heat-processed foods like idli.

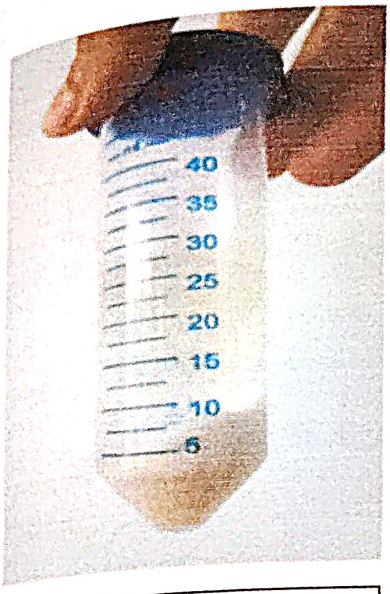

Figure 24: After centrifugation

Figure 25: UV-VIS Double Beam Spectrophotometer

Figure 26: TFC of rutin standard

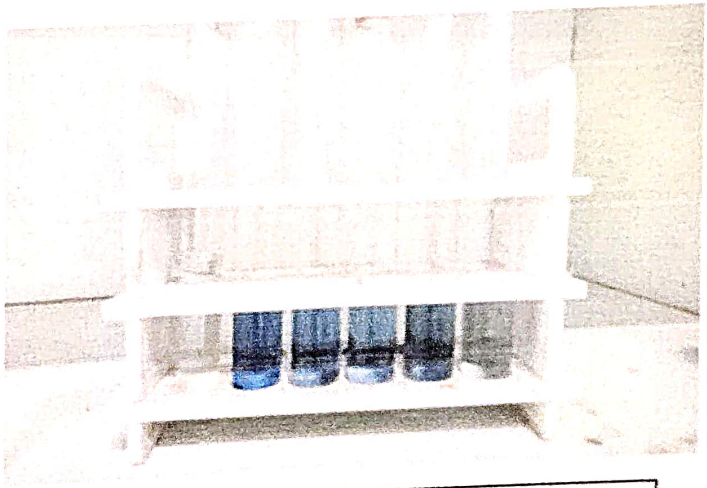

Figure 27: TPC of Galic acid

CONCLUSION

The present study demonstrated that *Ixora coccinea* flower extract possesses significant nutritional and antioxidant properties, making it a promising candidate for use as a natural food colorant. The presence of phytochemicals such as flavonoids, phenols, and anthocyanins, tannins, saponins along with a considerable vitamin C content, also have free radical scavenging activity which suggests health-promoting potential. When incorporated into food products, the extract contributed both color and bioactivity, although a reduction in phytochemical content was observed due to processing effects. Importantly, this study is among the first to explore the application of *Ixora coccinea* in food systems, bridging the gap between traditional medicinal uses and modern food innovation. Further studies focusing on stability, sensory evaluation, and consumer acceptance will strengthen its scope for commercial use in the natural food colorant industry.

FUTURE SCOPE

The current study highlights the potential of *Ixora coccinea* flower extract as a natural food colorant with notable nutritional and antioxidant properties. Future research can focus on the following areas:

- Investigating how processing and storage affect the color, vitamin C, and antioxidant properties of the extract in different food matrices.
- Improving the extraction process for better yield and retention of bioactive compounds using food-safe techniques.
- Expanding the application of *Ixora* extract into other food items like baked goods, beverages, or confectioneries.
- Using different solvents and extraction methods for nutritional profiling.
- Determining other nutrients, minerals, vitamins present in extract and developed food product.
- Determining antioxidant activity by other methods like FRAP, CUPRAC, ABTS etc.

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